

# AIRS Products Explain the Close Relationship Between CERES OLR Anomalies and the El Niño Index



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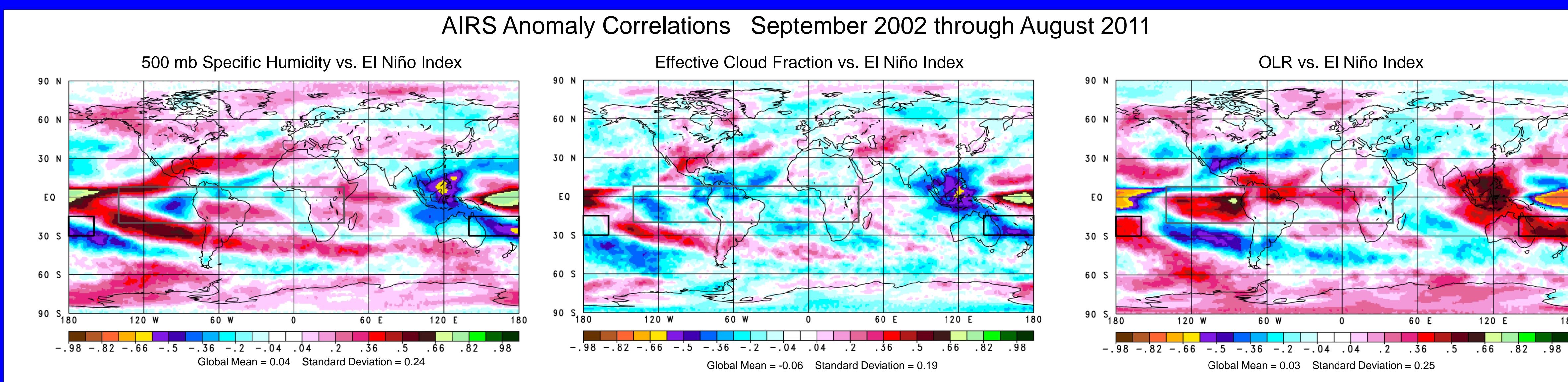
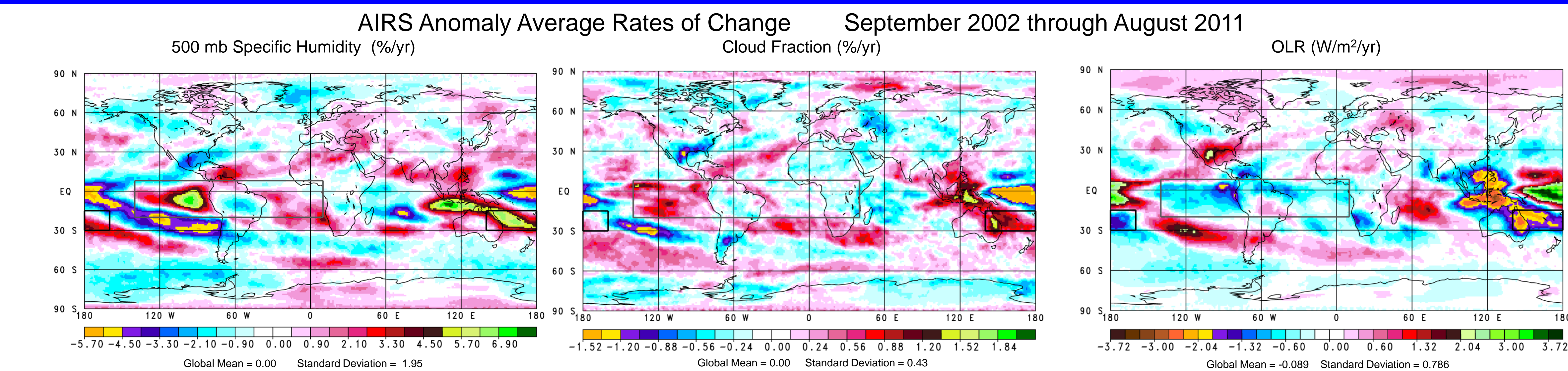
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## Nine Years of AIRS Products Depict the Inter Relationship between El Niño, Water Vapor, Cloud Cover, and OLR Anomalies



### Anomaly ARC's and Anomaly Correlations with El Niño

Water vapor and cloud cover anomaly ARC's are in phase with  $T_{skin}$  anomalies over the El Niño and surrounding regions

All fields show similar patterns of spatial correlations with the El Niño Index in the tropics

Tropical OLR decreases with increasing water vapor and cloud cover. Therefore tropical OLR ARC's and anomaly correlations are of opposite sign compared to those of water vapor and cloud cover.

OLR ARC's in the El Niño region and over Indonesia tend to cancel each other with regard to global and tropical mean.

### Skin Temperature Anomaly ARC's and Correlations with El Niño Index

Ocean skin temperatures have decreased significantly in the vicinity of the El Niño region over the last nine years.

Ocean skin temperatures have increased somewhat to the north, south, and west of the areas of cooling.

Hovmöller anomaly diagram shows that the time period starts with an El Niño (2002) and ends with La Niñas (2008, 2010)

Skin temperature anomalies over Indonesia are out of phase with, though smaller than, those at the dateline

Skin temperature anomalies in the above mentioned regions are highly positively or negatively correlated with the El Niño index

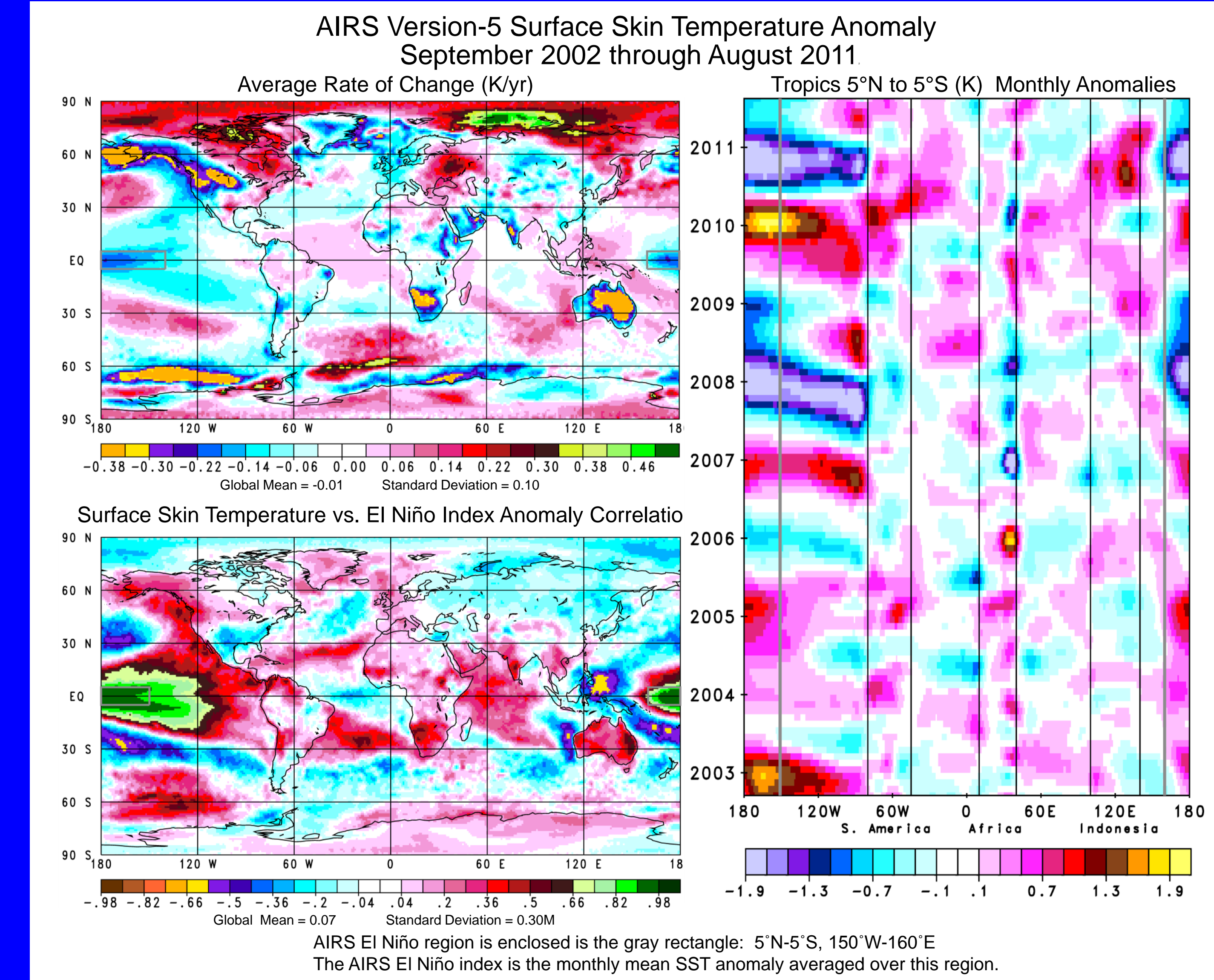
Skin temperature anomalies near Indonesia are very highly negatively correlated with the El Niño Index

### Significance of OLR Regions 1 and 2

Water vapor and cloud cover ARC's are very positive within OLR Regions 1 and 2

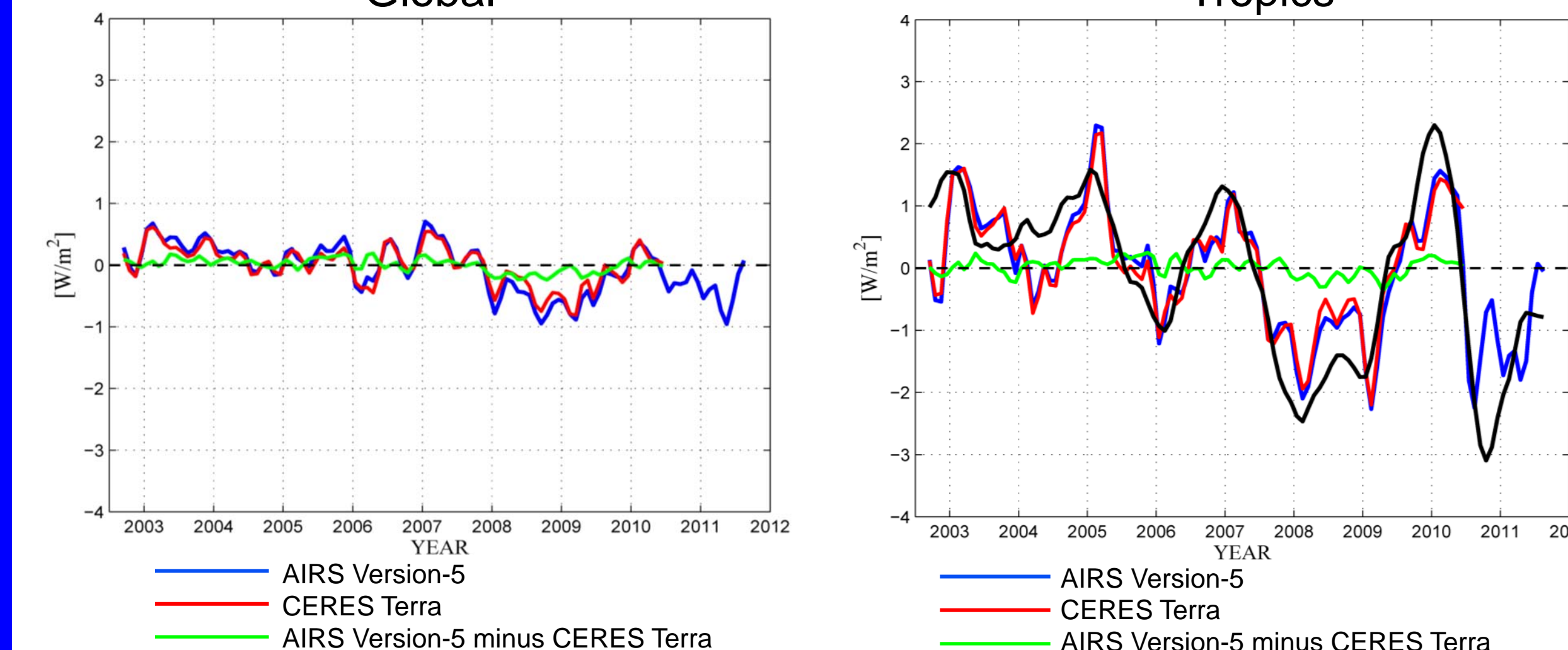
OLR ARC's are very negative within OLR Regions 1 and 2

OLR anomalies within Regions 1 and 2 are highly positively correlated with El Niño



## OLR Regions 1 and 2 Account for Recent Decreases in OLR

### OLR Anomaly Time Series September 2002 through June 2010



### AIRS and CERES OLR Anomaly Time Series Comparison September 2002 through June 2010

Data Set	Global	Tropical
AIRS ARC (W/m <sup>2</sup> /yr)	-0.0871 ± 0.0152	-0.1113 ± 0.0425
CERES Terra ARC (W/m <sup>2</sup> /yr)	-0.0646 ± 0.0130	-0.0995 ± 0.0400
AIRS minus CERES STD (W/m <sup>2</sup> )	0.108	0.139
AIRS/CERES Correlation	0.972	0.991
AIRS/El Niño Correlation	0.577	0.830
CERES/El Niño Correlation	0.543	0.824

Exclusion of OLR regions 1 and 2 from the calculation of global and tropical mean OLR ARC's reduces the ARC's to essentially zero and significantly reduces the correlations of otherwise global and tropical mean OLR anomaly time series with the El Niño index.

## Background Information

### Significance of AIRS OLR

AIRS OLR is a computed product for each AIRS field of regard (FOR) using an OLR RTA. Input data is AIRS retrieved  $T_{skin}$ ,  $T(p)$ ,  $q(p)$ ,  $O_3$ ,  $at$ , and  $P_{total}$ .

OLR<sub>CLR</sub> is also computed for each AIRS FOR using the same parameters but setting the cloud fraction  $at=0$ . Roughly 70% of all cases pass OLR<sub>CLR</sub> QC and are used to generate the AIRS level-3 OLR<sub>CLR</sub> product.

CERES products are derived from broad spectral band observations

Considered the "Gold Standard" of OLR and OLR<sub>CLR</sub> data

CERES OLR<sub>CLR</sub> represents CERES OLR values for scenes considered to be clear.

Roughly 10% of all cases are used to generate the CERES OLR<sub>CLR</sub> level-3 product

If anomalies and short term ARC's of AIRS OLR closely match those of CERES OLR, then:

This validates anomalies and short term ARC's of both AIRS and CERES OLR

This indirectly validates anomalies and short term ARC's of AIRS retrieved products

In addition, anomalies and short term ARC's of OLR can now be attributed to those of its component parts

### Data Sets Used

AIRS Science Team Version-5 monthly mean data obtained from Goddard DISC (level-3) OLR, OLR<sub>CLR</sub>,  $T_{skin}$ ,  $T(p)$ ,  $q(p)$ ,  $O_3$ ,  $at$ , and  $P_{total}$ . Presented on a 1°x1° latitude-longitude grid. 1:30 AM and 1:30 PM monthly mean values extracted separately and averaged together. Data products used extend to August 2011.

CERES Science Team monthly mean data obtained from Langley ASDC

All data presented on a 1°x1° latitude-longitude grid

Edition-2.5 CERES Terra OLR

Data products extend to June 2010

We did not use Edition-2.5 CERES Aqua OLR

Data products extend only to August 2009

### Definition of Anomalies and Average Rates of Change (ARC's)

Seven-year monthly climatologies were generated for each grid box by averaging data for seven consecutive Januaries, seven Februaries, ...

The monthly anomaly for each grid box is the difference of the value for that month from its seven year climatology

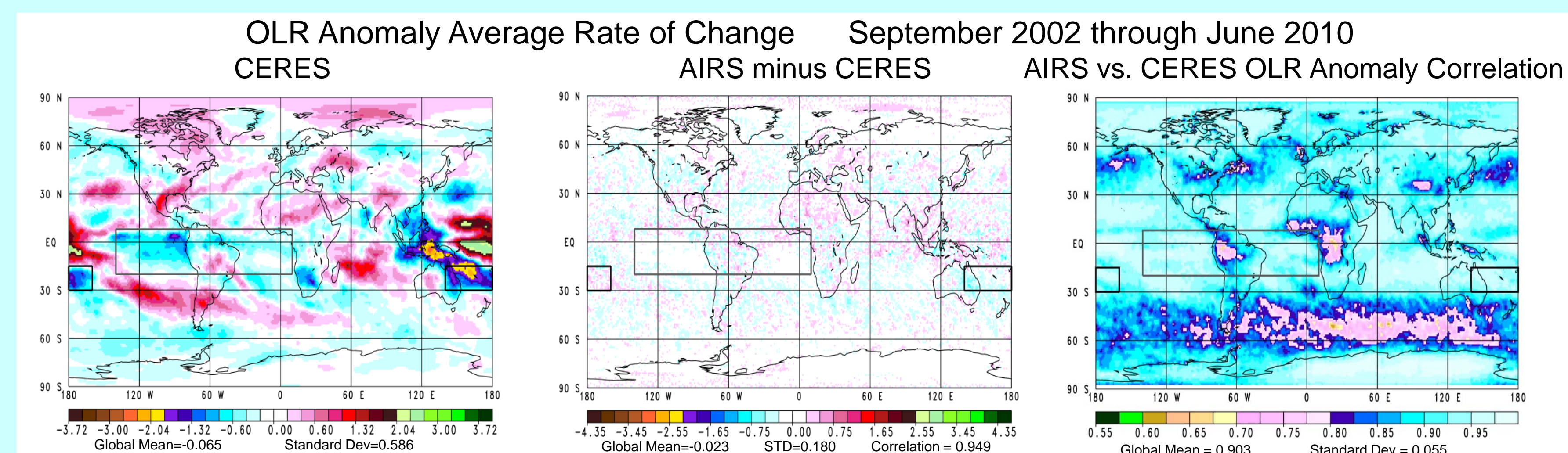
The Average Rate of Change (ARC) for a grid box is the slope of the straight line fit passing through the monthly anomaly time series

Values of ARC's depend on the extent of the time series used

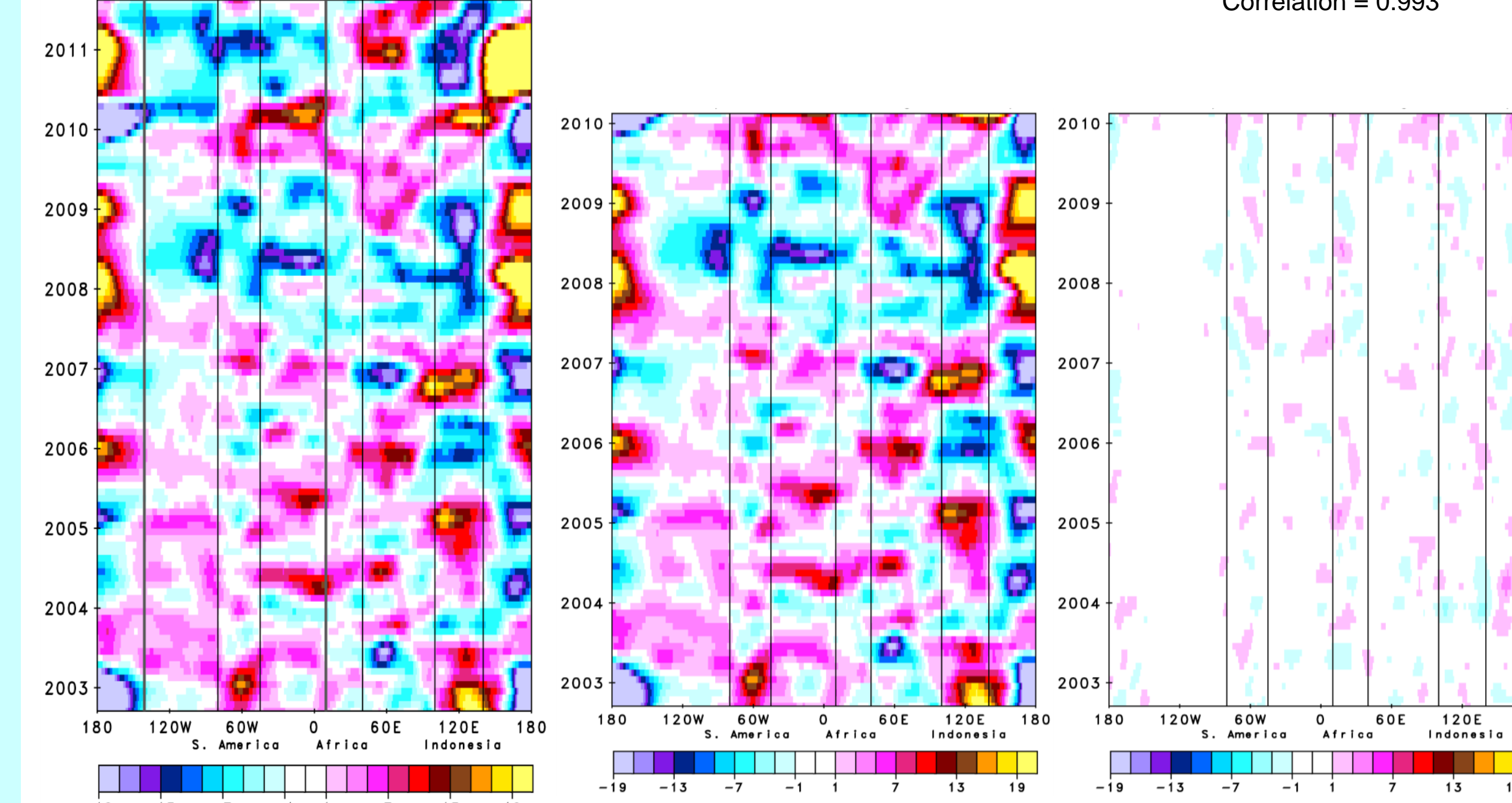
Spatial patterns are more important than precise values

An area mean ARC is the cosine latitude weighted average ARC over the area

## Spatial Comparison of AIRS and CERES OLR Anomaly Time Series



### Monthly Mean OLR Anomaly (W/m<sup>2</sup>) Tropics 5N to 5S



### Comparison Summary

AIRS and CERES Terra OLR anomaly time series agree well on a 1° spatial scale in every detail in the 7 year 10 month overlap period

The distribution of ARC's show very close agreement, with a spatial correlation of 0.949

Spatial anomaly time series have a correlation greater than 0.9 in most regions

Correlations drop to the range of 0.7 to 0.9 in cloudier regions

OLR ARC's over this time period are not indicative of future long term OLR changes. However, agreement of all details of anomaly time series as determined by both CERES and AIRS imply they are real.

It is desirable to maintain CERES and AIRS class instruments (or better) in the future, to corroborate, verify, and explain future OLR measurements.

### Area Mean Average Rates of Change of AIRS OLR (W/m<sup>2</sup>/yr) September 2002 through August 2011

Spatial Area	OLR ARC	OLR Anomaly Correlation with El Niño Index
Global	-0.089 ± 0.012	0.577
Tropical	-0.172 ± 0.034	0.834
Region 1	-0.491 ± 0.064	0.733
Region 2	-1.486 ± 0.171	0.793
Global excluding Region 1	-0.039 ± 0.010	0.302
Tropical excluding Region 1	-0.028 ± 0.023	0.637
Global excluding Region 1 and 2	-0.010 ± 0.010	0.022
Tropical excluding Region 1 and 2	-0.001 ± 0.022	0.545

### AIRS Version-5 Regional Anomaly Time Series September 2002 through August 2011

